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(54) **Machine for winding two pole stators**

Wickelmaschine für Bipolarständer

Machine de bobinage pour stators bipolaires

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## Description

### Background of the Invention

This invention relates to machines for winding two-pole stators for electric motors. In particular, the invention relates to machines for winding two-pole stators which do not employ wire-guiding forms, thereby permitting change-over from one stator type to another with a minimum of work.

GB-A-2091668 discloses a table for transferring workpieces from a winding station to another working station, said table being rotatable around a vertical axis and said working stations being disposed around the table. In this document, however, locking of the winding forms in the load/unload station clearly obtains even permanent positioning of the stator on the holding device of the turn table.

FR-A-2370659 discloses an annular chain conveyor solution for transferring pallets which carry stators to be processed by various stations. At the stations, in order to accomplish processing, the stator is removed from the pallet and positioned inside the station, or, the pallet together with the stator on it become removed from the conveyor and placed inside the station. For both these cases this document does not suggest how the stator is maintained in position when it is processed inside the winding station or inside the termination station.

### Summary of the invention

It is an object of this invention to provide a machine fed from a conveyor system for completely automated winding of stators within a very short cycle time.

It is another object of this invention to provide a very reliable and flexible machine, i.e., a machine able to wind stators of various stack diameters and stack heights.

These objects of the invention are accomplished by providing a two-pole stator winding machine according to claim 1 including a table mounted on a base for rotation about a vertical axis. Spaced from one another around the table are at least three working stations. These are (1) a station for feeding the machine with unwound stators from a conveyor placed alongside the machine and for subsequently returning the wound stators to said conveyor; (2) a winding station where one or more winding needles with alternating translatory and angular motion provide for winding each stator; and (3) a terminating station including means for anchoring the coil leads to the stator. The revolving table has stator housings fitted to it at distances related to the distances between the working stations. Each stator housing includes stator-containing means. The stator housings and table are equipped with mechanical, reciprocally meshing means, those on the table being located between the winding station and the load/unload station for rotating the stator housings about their horizontal axis which is tangential to the table between a position in which the axis of the stator-containing means is vertical and a position in which that axis is horizontal. The stator housings further include a spring to keep the housings in the position in which the axis of the associated stator-containing means is horizontal during motion of the table from the load/unload station through the winding station and to the terminating station.

### Brief Description of the Drawings

FIG. 1 is a side elevational view of a first embodiment of the invention in which the machine includes only one terminating station.

FIG. 2 is a top view of the machine of FIG. 1.

FIG. 3 is a top view, partly in section, of a stator housing fitted to the machine of FIGS. 1 and 2. FIG. 3 is rotated 180° relative to FIG. 2.

FIG. 4 is a front view of the revolving table of the machine of FIGS. 1 and 2, including the stator housings shown in FIG. 3. FIG. 4 is taken in the opposite direction from FIG. 1.

FIG. 5 is a partly sectional front view of the table of FIG. 4.

FIGS. 6 and 7 are plan view layouts of two different embodiments of the machine.

FIGS. 6a and 7a are surface developments of two details of FIGS. 6 and 7, respectively.

FIG. 8 is an alternative embodiment of the table shown in FIG. 4.

FIG. 9 is a perspective view showing a pallet and a stator housing at the load/unload station.

FIG. 10 is a perspective view showing a partially disassembled stator housing.

### Detailed Description of the Preferred Embodiments

As shown in FIGS. 1 and 2, a transport system 10 located at one side of the machine carries stators 11 on pallets 12. Next to conveyor 10 is a first working station indicated at A in FIG. 2. Station A is a load/unload station including a column 13 rotatable about a vertical axis by means of pneumatic cylinder 14 and gear 15. Column 13 carries arm 16 having a vertically slidable gripper 17. Gripper 17 is moved downward by means of pneumatic cylinder 19 with its shaft 20. After gripping stator 11, gripper 17 moves up. Column 13 then rotates 180° to bring gripper 17 and stator 11 into the position shown by arrow F in FIG. 1.

A stator housing 21 under gripper 17 (better seen in FIGS. 3 and 4) has an outer body 22. Fixed to one side of outer body 22 by screw 26' is a half-chuck 23 having inner sidewalls 24 defining an arc of a circle for engaging stator 11. On the opposite side, half-chuck 25 is fixed by screw 26 to transverse rod 27. Around screw 26, springs 28 are compressed between outer body 22 and half-chuck 25. By unscrewing screws 26 and 26',

half-chucks 23 and 25 can be quickly removed and replaced with others having different inner sidewalls 24 for stators with different stack diameters.

Rod 27 ends in rollers 29 slidable along surfaces 30 (FIG. 5) formed as circular arcs. The axis of arcs 30 is parallel to but not coincident with the pivotal axis X by which housing 21 is pivotally mounted to support 31.

As shown in FIG. 10, each stator housing 21 can be rapidly removed and replaced by unscrewing just two screws 18 and pulling the housing up and out. This operation may be necessary when the stators to be wound require different lead holding claws 9. In such cases, removal and replacement of both half-chucks and of claws 9 would take more time than replacing the whole stator housing 21 by unscrewing two screws 18.

Supports 31 are connected to rotatable table 32 carrying four stator housings 21 identical to the one previously described. Housings 21 are located 90° apart on table 32, and the table is fitted to a thrust bearing and indexed through 90° at each step, driven by conventional motor means (not illustrated).

The stationary base 33 (FIG. 4) of table 32 carries a vertical circular curved plate 34 for a portion of its circumference between load/unload station A and the last working station (FIG. 2). Plate 34 has a curvilinear upper surface 35 with its section increasing toward the load/unload station. Surface 35 is the running surface of roller 36 fixed to bar 37, which in turn is vertically slidable and pushed downwards by spring 38.

Bar 37 carries rack 39 which engages gear wheel 40 integral with the pivot pin of the axis X about which stator housing 21 is pivotable. In this way, when roller 36 runs along surface 35, the associated stator housing 21 rotates from the position shown in the center and on the right side of FIG. 4 (in which the stator is held with its axis horizontal) to the position shown on the left side of FIG. 4 (in which the stator is carried with its axis vertical) to facilitate loading and unloading of stators 11 in housings 21 by gripper 17. FIG. 9 shows that, with stator housing 21 turned with its axis vertical and with the gripper arms vertical, gripper 17 is able to transfer stators with different stack heights between pallet 12 and stator housing 21 without the need to adjust either the gripper or the housing. Another advantage is that stator 11 reaches its proper position on pallet 12 and inside stator housing 21 by gravity, without the need to adjust any of the apparatus, thereby reducing production costs.

As shown in FIGS. 4 and 5, the supports 31 of each stator housing 21 are fixed to sliders 41 which move on radial rods 43. Springs 42 maintain supports 31 toward the central vertical rotation axis of table 32. Cylinder 44, having the same axis as the rotation axis of table 32, carries a rod 45 on the end of which is fixed an appendage that has an inclined sidewall 46 (FIG. 5) projecting at the side opposite to the load/unload station. After each 90° indexing of table 32, cylinder 44 retracts rod 45 so that inclined surface 46 goes from the position shown in dashed lines in FIG. 5 to the position shown in full lines, thereby pushing the slider 41 associated with the stator housing 21 adjacent winding station B away from the center of table 32 as roller 47 slides along inclined surface 46. In this way, as shown in FIGS. 1 and 2, the stator housing adjacent winding station B is pushed toward winding station B where one or more winding needles 48 wind stator 11 inside stator housing 21.

The kinematic system 49 (FIG. 2) moving needles 48 will not be explained in detail here, nor will the cutting means 50 (FIG. 1) which cut off the leads after winding, because the details of these elements do not concern the present invention.

Terminating station C (FIG. 2), where the coil leads are anchored to the stator, is situated between winding station B and load/unload station A, with the revolving table 32 indexing clockwise. Terminating station C has a terminating group moving along three axes, controlled by a step motor or a D.C. motor with encoder. The group has wire gripping means for catching the coil lead and putting it into the stator terminal. The gripping means are combined with crimping means for completing termination of the stator. Again, this station will not be described in detail because it does not concern the present invention.

As explained above, the machine includes a first station A for loading and unloading, with gripper 17 on column 13 which transfers stator 11 between the conveyor system and the stator housing with its half-chucks 23 and 25, said housing in said station having its axis vertical.

The stator inside stator housing 21 arrives at a second station D, which in the embodiment illustrated in FIG. 2 is a waiting or intermediate station, after a 90° rotation about its axis X, so that stator 11 (held by half-chucks 23 and 25) arrives with its axis horizontal. The half-chucks firmly grip stator 11, because from the moment when the stator housing starts to rotate about axis X, rollers 29 running on curved surface 30 release the force opposing the operation of springs 28 so that these springs can push half-chuck 25 toward half-chuck 23, thereby locking the stator inside the housing. The above-described rotation of housing 21 starts as soon as table 32 revolves clockwise and roller 36 leaves cam surface 35. Spring 38 then pushes sliding bar 37 downward, so that rack 39 rotates gear wheel 40 which is also the pivoting point of housing 21.

After another 90° indexing of revolving table 32, the stator housing 21 with the stator to be wound arrives at winding station B. Cylinder 44 then retracts its rod so that inclined sidewall 46 pushes slider 41 (together with housing 21) outward, thereby bringing the stator near the winding needles which now start winding the stator.

After the coils have been wound, revolving table 32 again indexes through 90°, bringing the stator inside the housing to terminating station C where the coil leads are anchored to the stator terminals.

A further 90° indexing of revolving table 32 brings

the stator back to load/unload station A. Gripper 17 is pivoted over the stator, descends, grips the stator, and unloads it onto conveyer 10. During this last indexing of the table, roller 36, running along surface 35, had moved sliding bar 37 upwards. Rack 39 rotates gear wheel 40 so that housing 21 arrives at the load/unload station with the stator axis vertical. At the same time, rollers 29, running along surfaces 30, cause half-chuck 25 to be moved outward, unlocking stator 11.

An alternative embodiment is shown in FIG. 6 in which load/unload station A and winding station B are adjacent to one another, followed by two terminating stations C and D. This arrangement can be especially advantageous for stators with intermediate taps which require two successive terminating operations on the same stator.

FIGS. 6 and 6a concern a first embodiment as described above in which the stator leaves winding station B with the coil leads held by claws 9 (FIG. 10) on stator housing 21. After a 90° indexing of revolving table 32, the wound stator arrives at the first terminating station C where the coil leads coming from stator face a are taken out of the claws and terminated on the stator. Then the revolving table 32 indexes again through 90° and brings the stator from terminating station C to the second terminating station D. Roller 36 runs over a first section 35 (FIG. 6a) of cam 34 similar to the one shown in FIG. 4. However, in this embodiment, gear wheel 40' (FIG. 8), acting as the pivoting point of housing 21, instead of directly engaging rack 39 does so by way of gear wheels 50 and 51. As a result of this gear transmission, the housing 21 rotates through 180° on its way from the first to the second terminating stations, where the leads on stator face b are terminated.

After operation of second terminating station D, revolving table 32 indexes again through 90° to bring the stator from the second terminating station to load/unload station A. During this last indexing, roller 36 runs over the second section 35' of cam 34 (FIG. 6a). Gear wheels 40', 50, and 51 rotate the stator housing through 90°, so that the stator arrives at the load/unload station with its axis vertical.

Another embodiment with two terminating stations is shown in FIG. 7. After terminating coil leads on stator face a at terminating station C, revolving table 32 indexes through 90° and brings the stator housing to terminating station D. In this embodiment the stator housing 21 is the same as shown in FIG. 4, with rack 39 engaging only one gear wheel 40. As shown in FIG. 7a cam 34 permits only a 90° rotation of the stator housing, presenting stator face b, with the stator axis vertical at terminating station D, and maintaining that orientation of the stator housing through load/unload station A. The terminating group of station D is accordingly located above the stator housing and carries out the same operations for anchoring the leads to stator face b as at station C. After termination at station D, the revolving table indexes again through 90° and brings the stator to load/unload station A with the stator axis still vertical.

The advantage of the embodiment shown in FIG. 7 as compared to the embodiment shown in FIG. 6 is that it reduces machine dimensions at station D.

**Claims**

1. A machine for winding a stator (11) having a longitudinal axis, said machine comprising:

   - a movable table (32) for transferring said stator (11) between a first station (B), and a second station (C), wherein said first station (B) is a stator winding station having at least one needle (48) for travelling through said stator (11) to deliver wire to wind the coils of said stator and said second station (C) is a stator termination station for manipulating leads of said coils;
   - a stator housing (21) assembled on said movable table (32), said stator housing (21) being adapted to receive and hold said stator in position to be wound with its longitudinal axis horizontal, and a loading and unloading means (17) for transferring said stator to and from said table before and after processing by said winding station and said termination station;

   said machine being characterised in that it further comprises opposing chuck members (23, 25) movable towards each other within said housing (21) to releasably clamp said stator by engaging inner sidewalls (24) of said chuck members with said stator (11) in order to hold said stator (11) during winding at said winding station (B) and during termination at said terminating station (C); said means (17) for loading and unloading said stator (11) loads and unloads said stator between said opposing chuck members (23, 25) and a conveyor (10).

2. The machine defined in claim 1 wherein said stator housing (21) is provided with lead holding claws (9) and further comprising means (18) for replacing said stator housing (21) with another stator housing when different lead holding claws are required in said winding and termination stations (B, C).

3. The machine defined in claim 1 wherein said table (32) is mounted for rotation about a first vertical axis and said first and second stations (B, C) are positioned around said table.

4. The machine defined in claim 1 further comprising a third station (A) having said means (17) for loading and unloading said stators and wherein said third station (A) is spaced from said first and second stations (B, C) around said table.

5. The machine defined in claim 1 wherein the inner side walls (24) of said opposing chuck members (23, 25) engage said stator along an arc of a circle to clamp said stator.

6. The machine defined in claim 5 wherein said pair of opposing chuck members (23, 25) hold a stator (11) having a first diameter and being further characterised in that said pair of opposing chuck members can be removed from said machine and replaced with another pair of opposing chuck members to hold a stator having a second stator diameter.

7. The machine defined in any of the preceding claims, further comprising means (41, 43, 44, 46) for providing relative radial motion between said winding station (B) and said stator housing (21), so as to position said at least one winding needle (48) adjacent said stator housing (21).

8. The machine defined in any of the preceding claims, further comprising a stationary actuator (35) member located adjacent said means (17) for loading and unloading said stator for moving said opposing chuck members (23, 25) to releasably clamp said stator (11) so that said stator can be loaded and unloaded by said means (17) for loading and unloading.

9. The machine defined in claim 8 wherein said stationary actuator member (35) comprises means for following a cam surface (30, 35) configured to move said opposing chuck members (23, 25) in order to hold said stator when said table (32) moves to transfer said stator.

10. The machine defined in any of the preceding claims wherein said means (17) for loading and unloading said stator (11) loads and unloads said stator (11) between said conveyor (10) and said table (32) by maintaining said stator (11) vertical.

**Patentansprüche**

1. Maschine zum Wickeln eines Stators (11) mit einer Längsachse, umfassend:

   - einen beweglichen Tisch (32) zum Überführen des Stators (11) zwischen einer ersten Station (B) und einer zweiten Station (C), wobei die erste Station (B) eine Statorwickelstation ist, die mindestens eine Nadel (48) zum Durchfahren des Stators (11) aufweist, um den Draht zum Wickeln der Statorspule zu liefern, und wobei die zweite Station (C) eine Statoranschlußstation zum Bearbeiten der Spulendrähte ist;
   - ein auf dem beweglichen Tisch (32) montiertes Statorgehäuse (21), das ausgelegt ist, um den Stator in einer Position aufzunehmen und zu halten, um ihn in horizontaler Lage seiner Längsachse zu wickeln, und Be- und Entlademittel (17), um den Stator vor und nach dem Bearbeiten durch die Wickelstation und die Anschlußstation auf und von dem Tisch zu überführen;

   wobei die Maschine dadurch gekennzeichnet ist, daß sie weiterhin gegenüberliegende Spannbauteile (23, 25) umfaßt, die innerhalb des Statorgehäuses (21) aufeinander zu bewegbar sind, um den Stator durch Ineingriffbringen von inneren Seitenwänden (24) der Spannbauteile mit dem Stator (11) lösbar festzuspannen, um den Stator (11) während des Wickelns an der Wickelstation (B) und während des Anschließens an der Anschlußstation (C) festzuhalten; wobei die Be- und Entlademittel (17) des Stators (11) den Stator zwischen den gegenüberliegenden Spannbauteilen (23, 25) und einem Förderband (10) be- und entlädt.

2. Maschine nach Anspruch 1, bei der das Statorgehäuse (21) mit Drahthalteklemmen (9) versehen ist und weiterhin Mittel (18) aufweist, um das Statorgehäuse (21) gegen ein anderes Statorgehäuse auszutauschen, falls unterschiedliche Drahthalteklemmen an der Wickel- und Anschlußstation (B,C) erforderlich sind.

3. Maschine nach Anspruch 1, bei der der Tisch (32) drehbar um eine erste vertikale Achse befestigt ist und bei der die erste und zweite Station (B,C) um diesen Tisch herum angeordnet sind.

4. Maschine nach Anspruch 1, weiterhin eine dritte Station (A) umfassend, die Mittel (17) zum Be- und Entladen der Statoren aufweist, und bei der die dritte Station (A) von der ersten und zweiten Station (B,C) um den Tisch herum beabstandet ist.

5. Maschine nach Anspruch 1, bei der die inneren Seitenwände (24) der sich gegenüberliegenden Spannbauteile (23, 25) mit dem Stator entlang eines kreisförmigen Bogenstückes in Eingriff kommen, um den Stator festzuspannen.

6. Maschine nach Anspruch 5, bei der das sich gegenüberliegende Spannbauteilpaar (23, 25) einen Stator (11) festhält, der einen ersten Durchmesser aufweist, und die weiterhin dadurch gekennzeichnet ist, daß das sich gegenüberliegende Spannbauteilpaar aus der Maschine entnommen und gegen ein anderes sich gegenüberliegendes Spannbauteilpaar ausgetauscht werden kann, um einen Stator festzuhalten, der einen zweiten Statordurchmesser aufweist.

7. Maschine nach mindestens einem der vorhergehenden Ansprüche, weiterhin Mittel (41, 43, 44, 46) umfassend, um eine relative Radialbewegung zwischen der Wickelstation (B) und dem Statorgehäuse (21) zu ermöglichen, um die mindestens eine Wickelnadel (48) so zu positionierten, daß sie an das Statorgehäuse (21) angrenzt.

8. Maschine nach mindestens einem der vorhergehenden Ansprüche, weiterhin ein stationäres Betätigungselement (35) umfassend, das an die Mittel (17) zum Be- und Entladen des Stators angrenzt, um die gegenüberliegenden Spannbauteile (23, 25) zu bewegen, um den Stator (11) lösbar festzuspannen, so daß der Stator durch die Be- und Entlademittel (17) be- und entladen werden kann.

9. Maschine nach Anspruch 8, bei der das stationäre Betätigungselement (35) Mittel zum Folgen einer Nockenfläche (30, 35) umfaßt, die so konfiguriert sind, die gegenüberliegenden Spannbauteile (23, 25) zu bewegen, um den Stator festzuhalten, wenn sich der Tisch (32) zum Überführen des Stators bewegt.

10. Maschine nach mindestens einem der vorhergehenden Ansprüche, bei der die Be- und Entlademittel (17) des Stators (11) den Stator (11) zwischen dem Förderband (10) und dem Tisch (32) be- und entladen, während der Stator vertikal gehalten wird.

**Revendications**

1. Machine permettant d'enrouler un stator (11) présentant un axe longitudinal, ladite machine comprenant :

   - une table mobile (32) permettant de transférer ledit stator (11) entre un premier poste (B) et un deuxième poste (C), dans lequel ledit premier poste (B) est un poste d'enroulement de stator présentant au moins une aiguille (48) apte à se déplacer à travers tout ledit stator (11) afin de distribuer le fil pour enrouler les bobines dudit stator, et ledit deuxième poste (C) est un poste de terminaison du stator permettant de manipuler les bornes terminales desdites bobines ;
   - un boîtier de stator (21) assemblé sur ladite table mobile (32), ledit boîtier de stator (21) étant adapté pour recevoir et maintenir ledit stator en position pour être enroulé en ayant son axe longitudinal horizontal, et un moyen de chargement et de déchargement (17) permettant de transférer ledit stator vers et depuis ladite table avant et après traitement audit poste d'enroulement et audit poste de terminaison ;

   ladite machine étant caractérisée en ce qu'elle comprend en outre des éléments d'étau opposés (23, 25) qui peuvent se déplacer l'un vers l'autre à l'intérieur dudit boîtier (21) afin de serrer, de façon libérable, ledit stator en amenant en contact les parois intérieures (24) desdits éléments d'étau contre ledit stator (11) afin de maintenir ledit stator (11) pendant l'enroulement audit poste d'enroulement (B), et pendant la terminaison audit poste de terminaison (C) ; ledit moyen (17) de chargement et de déchargement dudit stator (11) chargeant et déchargeant ledit stator entre lesdits éléments d'étau opposés (23, 25) et un convoyeur (10).

2. Machine selon la revendication 1, dans laquelle ledit boîtier de stator (21) est muni de pinces de maintien des bornes terminales (9) et comprend en outre un moyen (18) permettant de remplacer ledit boîtier de stator (21) par un autre boîtier de stator lorsque différentes pinces de maintien des bornes terminales sont nécessaires auxdits postes d'enroulement et de terminaison (B, C).

3. Machine selon la revendication 1, dans laquelle ladite table (32) est montée de façon à pouvoir tourner autour d'un premier axe vertical, et lesdits premier et deuxième postes (B, C) sont positionnés autour de ladite table.

4. Machine selon la revendication 1, comprenant en outre un troisième poste (A) comportant ledit moyen (17) permettant de charger et de décharger lesdits stators, et dans laquelle ledit troisième poste (A) est espacé desdits premier et deuxième postes (B, C) autour de ladite table.

5. Machine selon la revendication 1, dans laquelle les parois intérieures (24) desdits éléments d'étau opposés (23, 25) contactent ledit stator le long d'un arc de cercle pour serrer ledit stator.

6. Machine selon la revendication 5, dans laquelle ladite paire d'éléments d'étau opposés (23, 25) maintient un stator (11) présentant un premier diamètre, caractérisée en outre en ce que ladite paire d'éléments d'étau opposés peut être enlevée de ladite machine et remplacée par une autre paire d'éléments d'étau opposés pour maintenir un stator présentant un second diamètre de stator.

7. Machine selon l'une quelconque des revendications précédentes, comprenant en outre un moyen (41, 43, 44, 46) permettant de fournir un mouvement radial relatif entre ledit poste d'enroulement (B) et ledit boîtier de stator (21), de façon à positionner ladite au moins une aiguille d'enroulement (48) adjacente audit boîtier de stator (21).

8. Machine selon l'une quelconque des revendications précédentes, comprenant en outre un élément fixe d'actionnement (35) situé près dudit moyen (17) permettant de charger et de décharger ledit stator, afin de déplacer lesdits éléments d'étau opposés (23, 25) pour serrer, de façon libérable, ledit stator (11) de telle sorte que ledit stator puisse être chargé et déchargé par ledit moyen (17) de chargement et de déchargement.

9. Machine selon la revendication 8, dans laquelle ledit élément fixe d'actionnement (35) comprend un moyen permettant de suivre une surface de came (30, 35) configurée de façon à déplacer lesdits éléments d'étau opposés (23, 25), afin de maintenir ledit stator lorsque ladite table (32) se déplace pour transférer ledit stator.

10. Machine selon l'une quelconque des revendications précédentes, dans laquelle ledit moyen (17) de chargement et de déchargement dudit stator (11) charge et décharge ledit stator (11) entre ledit convoyeur (10) et ladite table (32) en maintenant ledit stator (11) vertical.

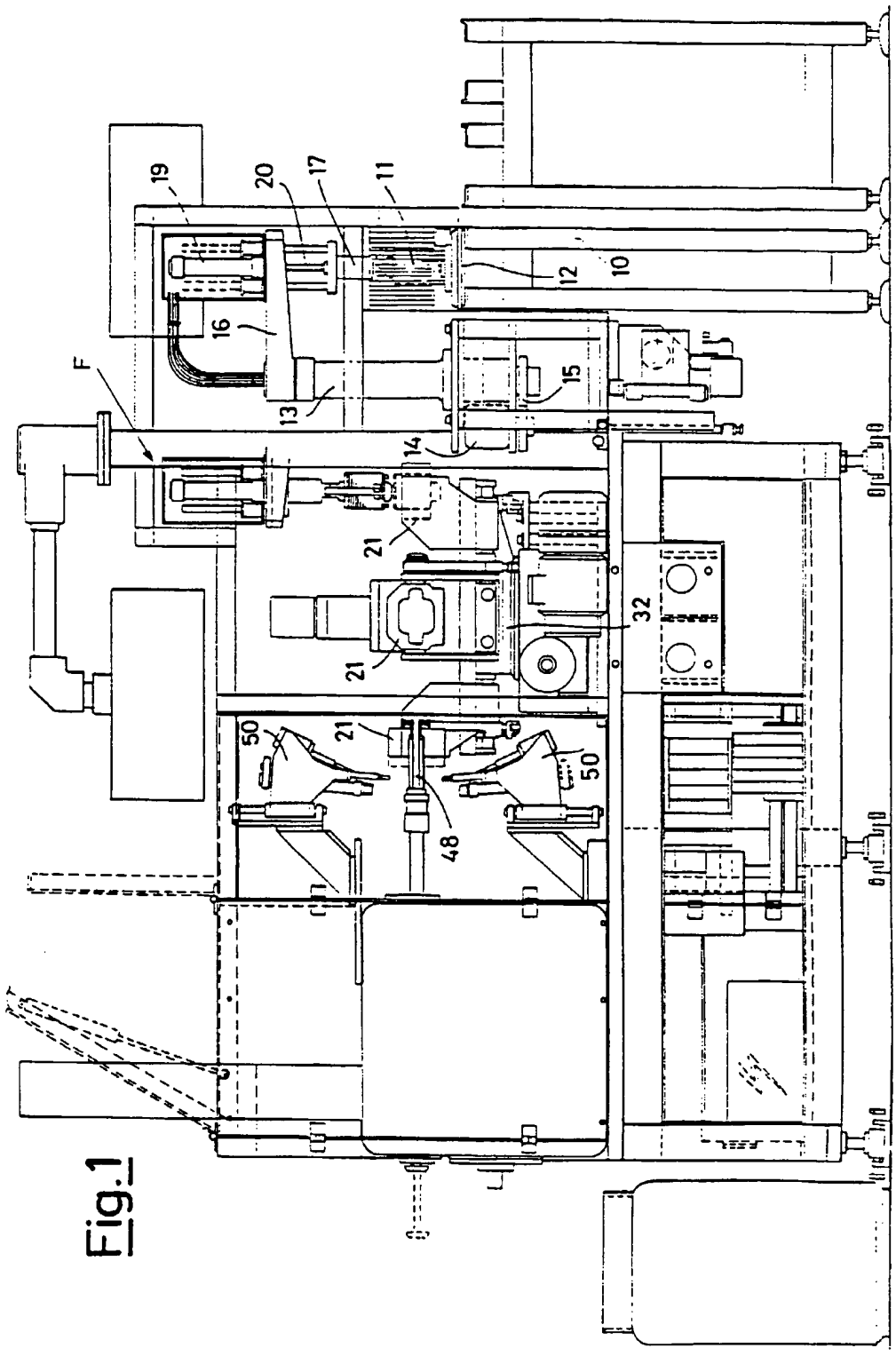


Fig.1

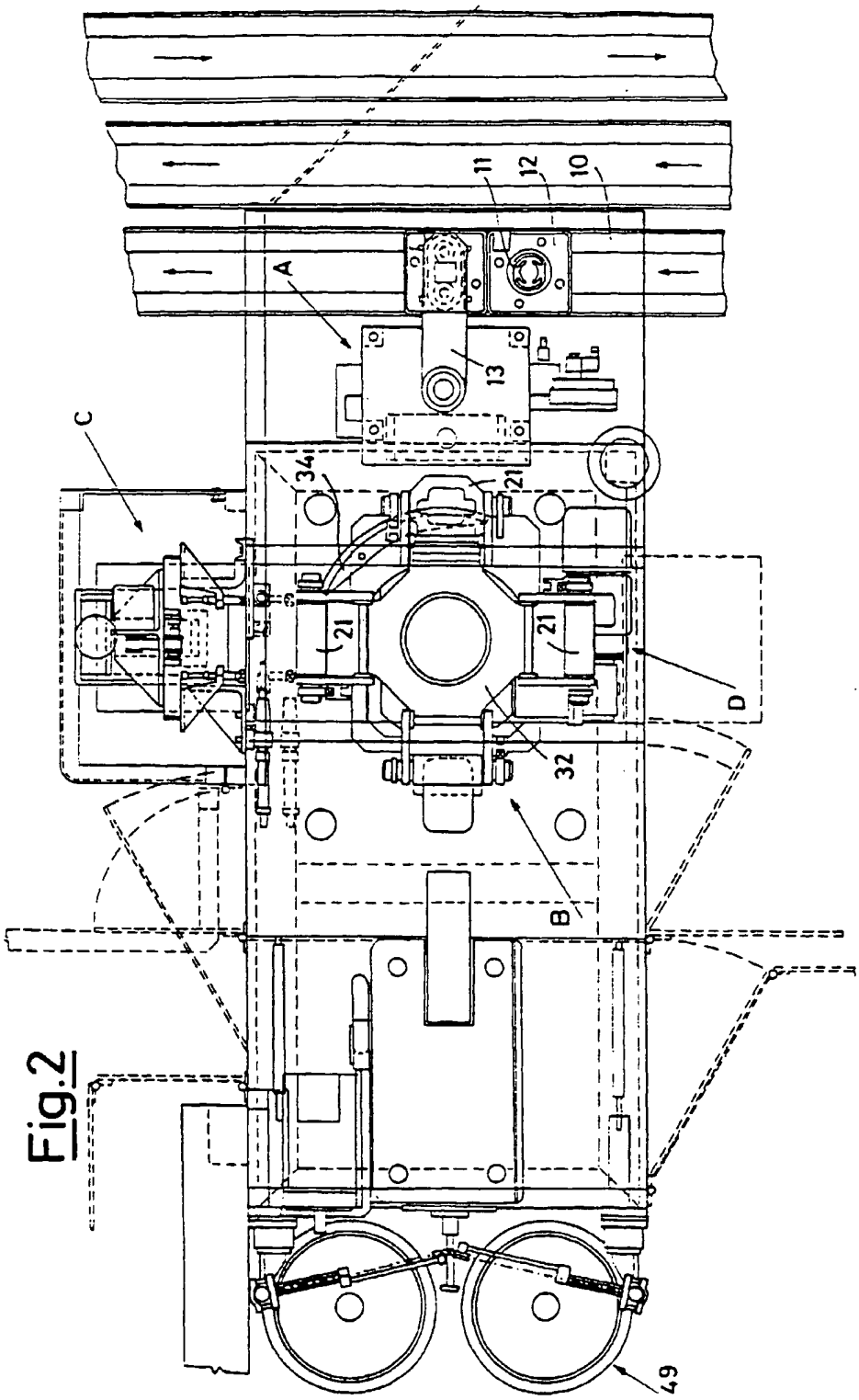


Fig.2

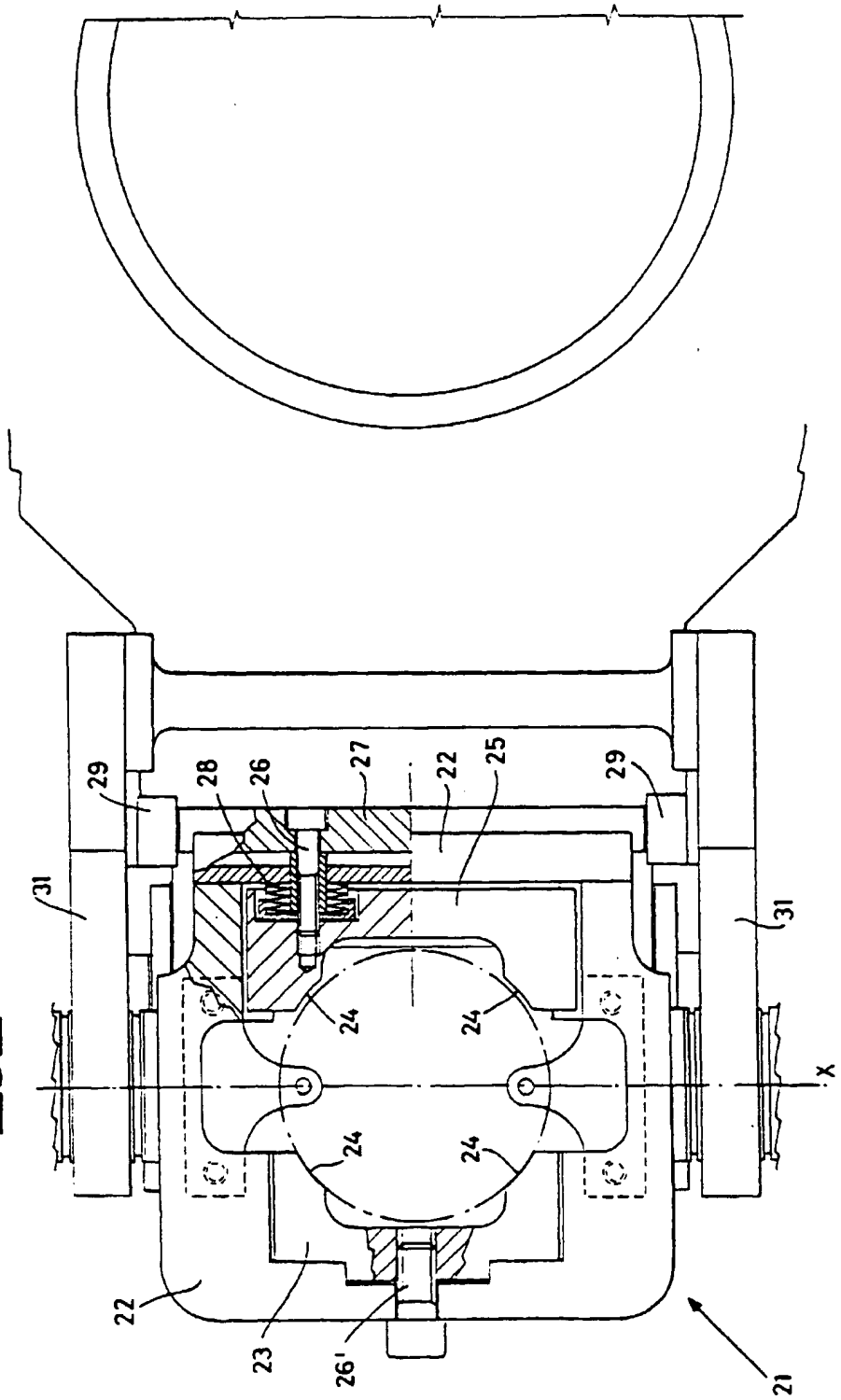


Fig.3

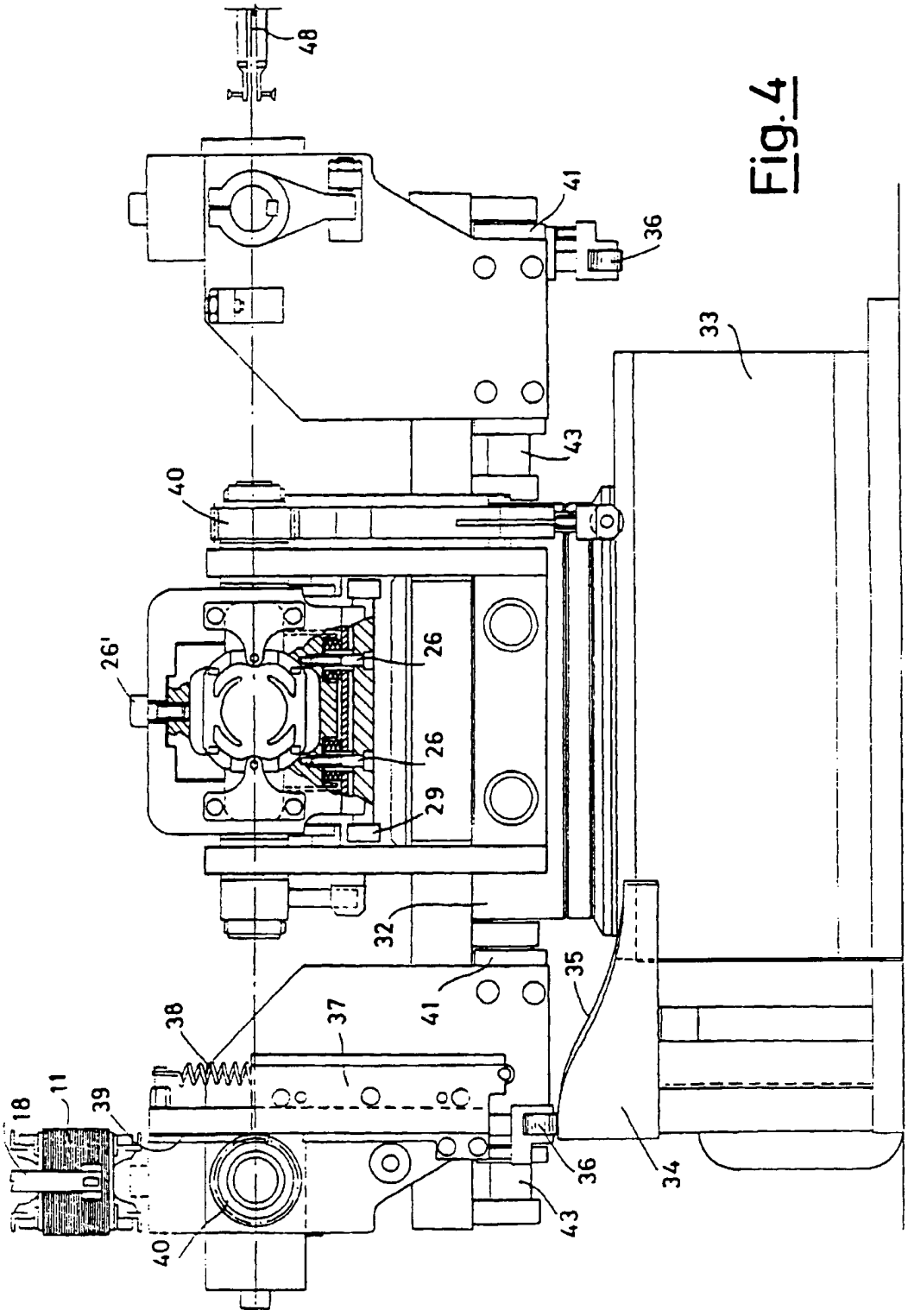


Fig.4

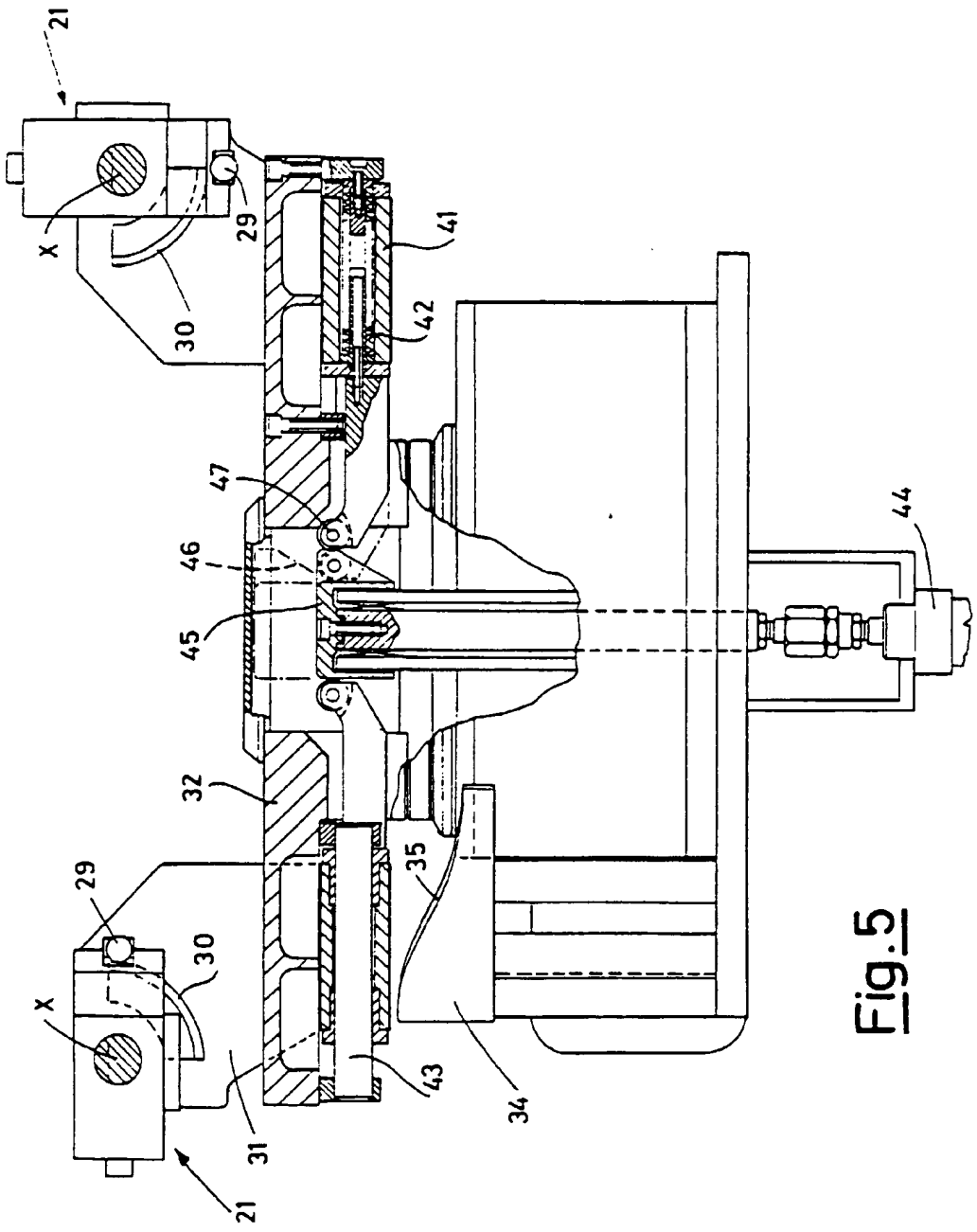


Fig.5

Fig.7

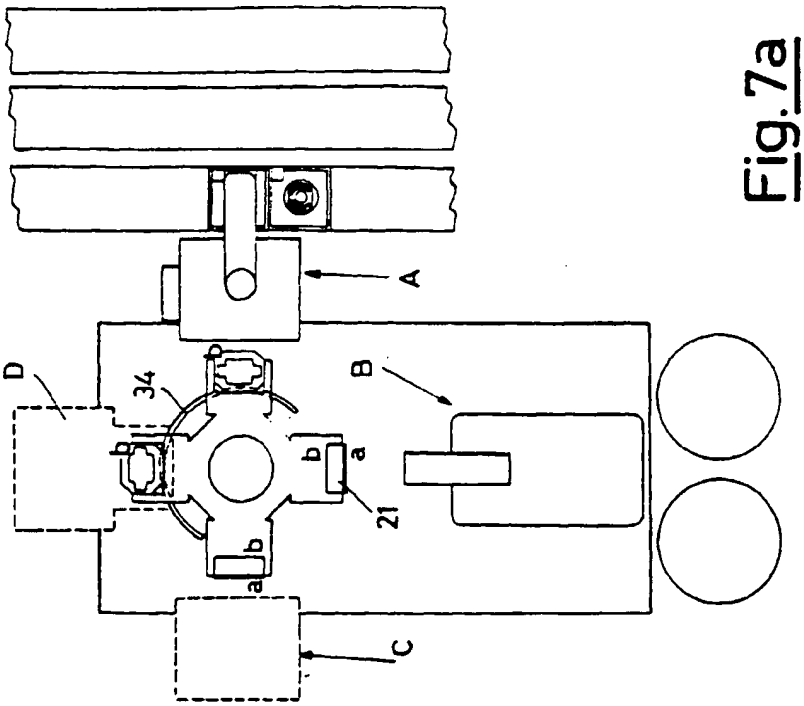


Fig.7a

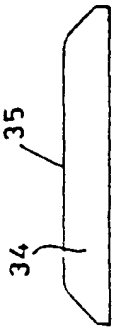


Fig.6

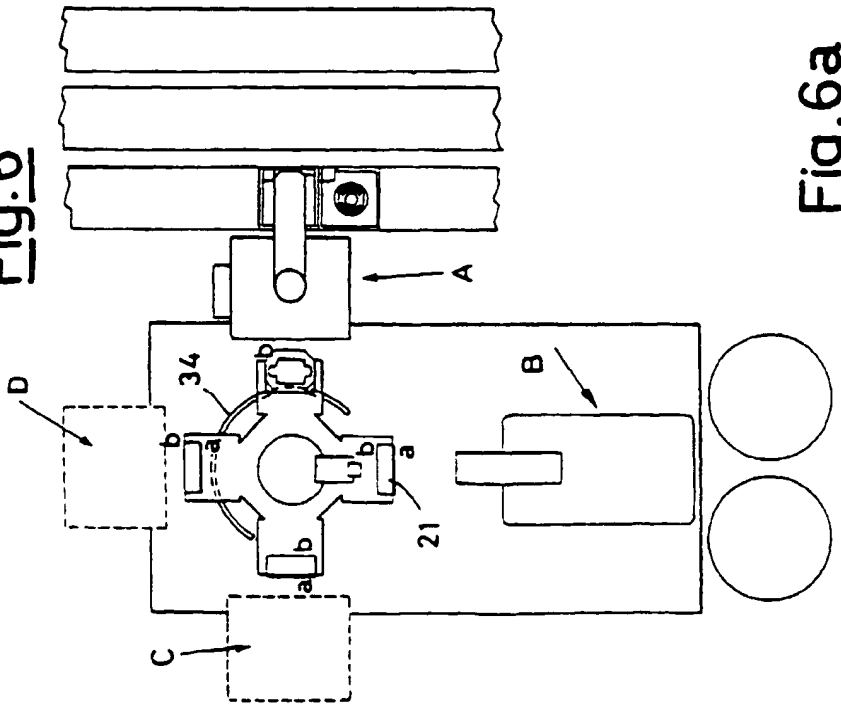


Fig.6a

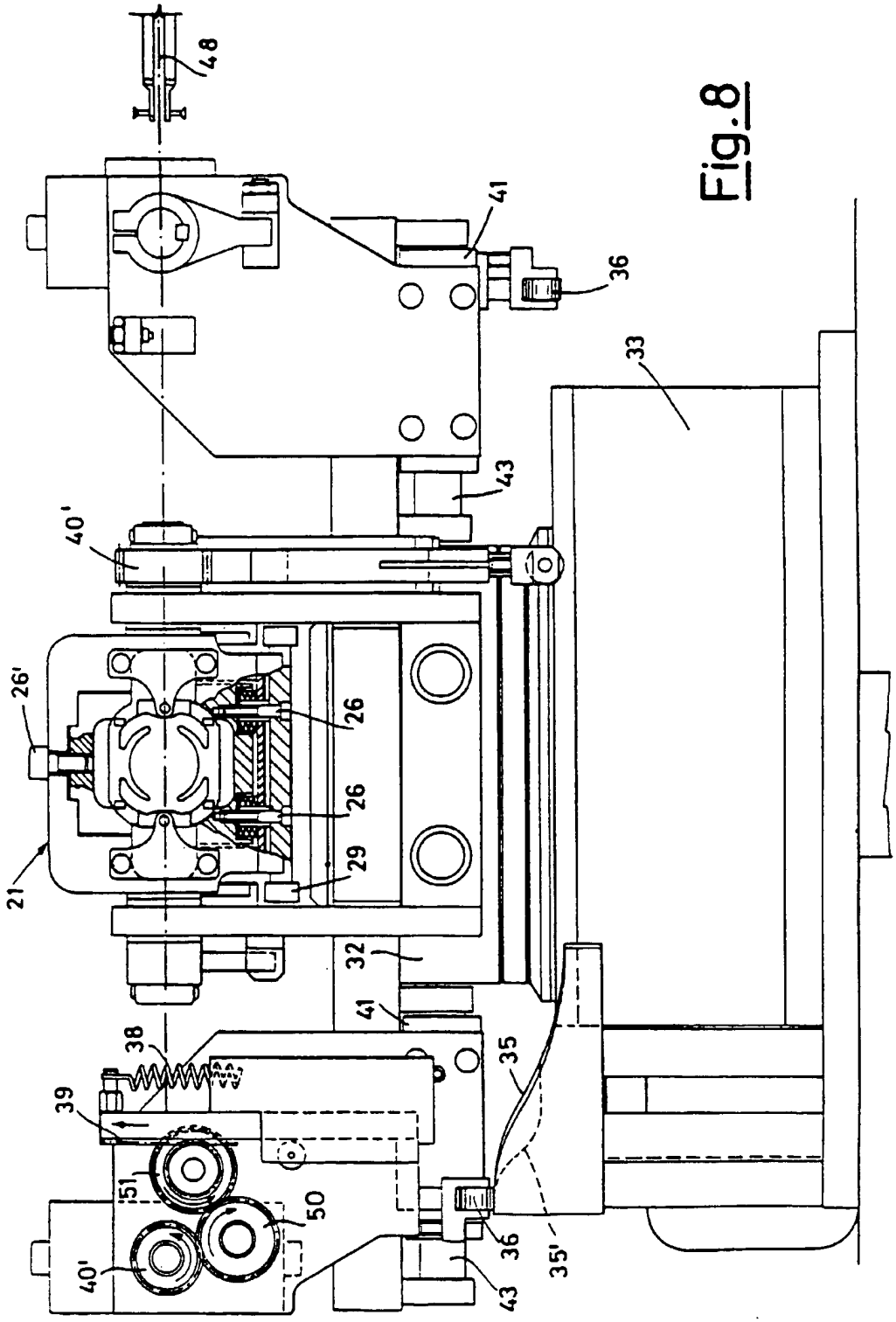


Fig.8

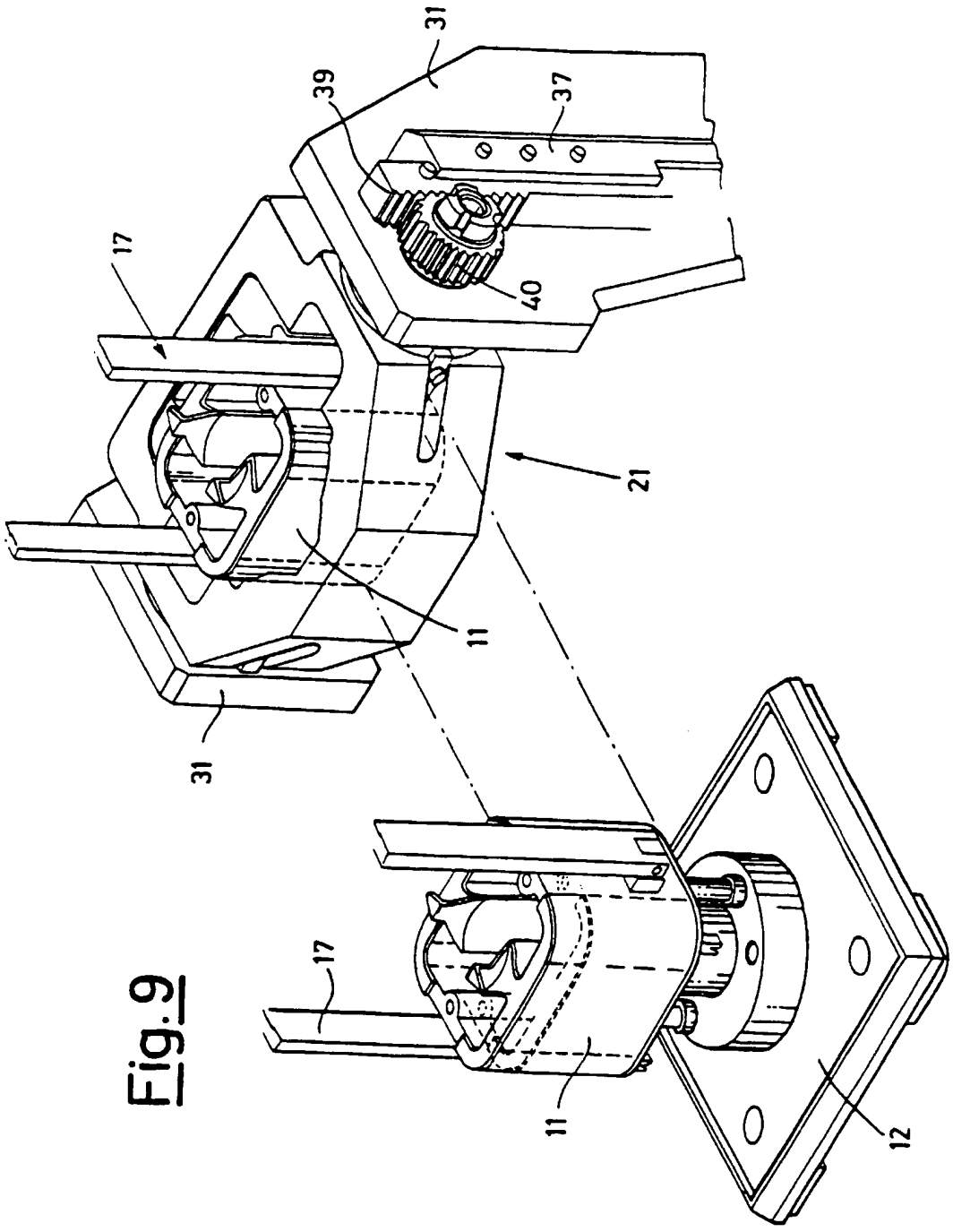


Fig.9

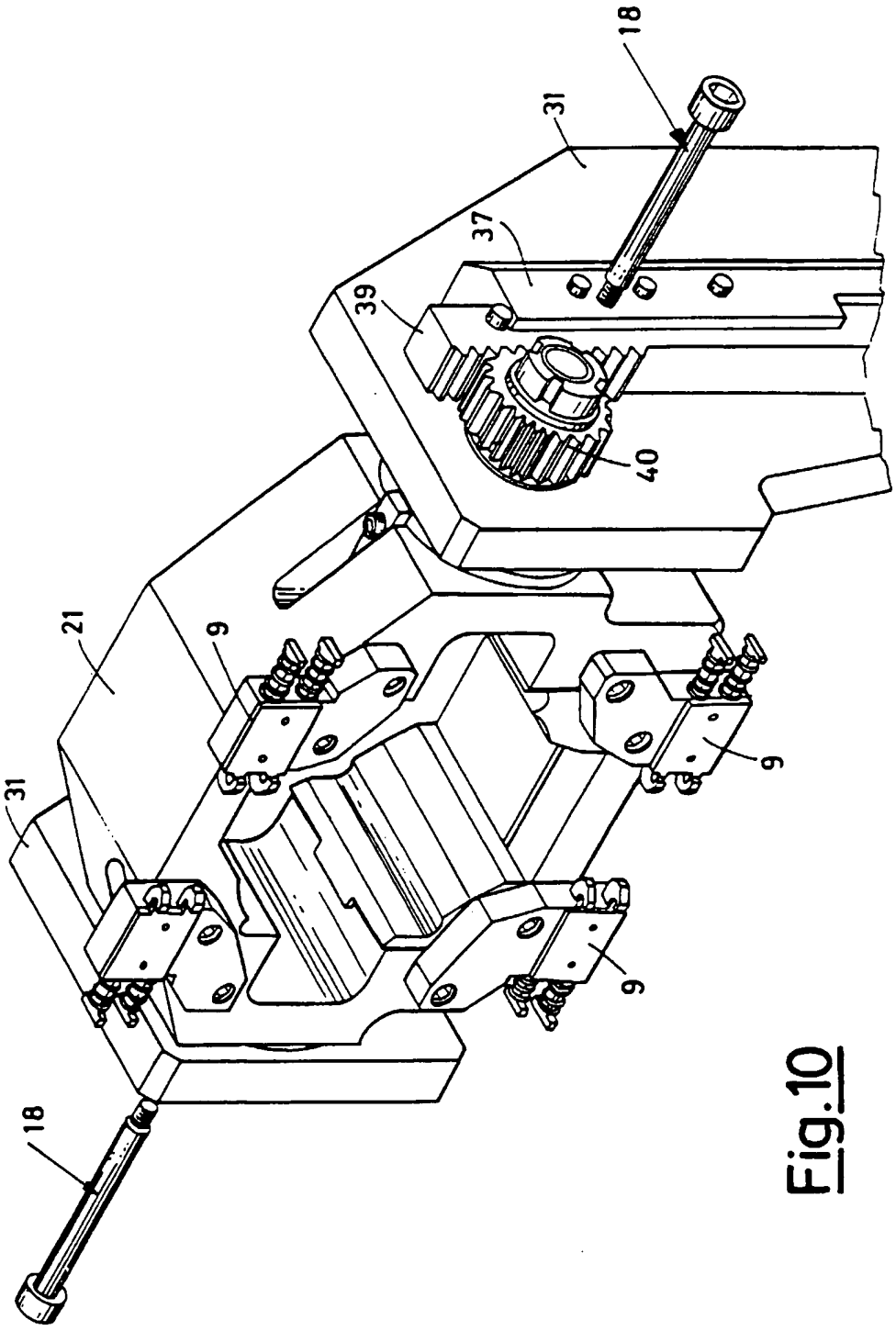


Fig.10